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ABSTRACT

A study was conducted to address the question of what impact the expansion of employment and training programs for youth (such as the Youth Employment Demonstration Projects Act of 1977) is likely to have on employment and unemployment of young people. The method used in the analysis was to specify a model (similar to the Markov model) of the youth labor market which focuses on turnover flows between employment, unemployment, and school; and then to introduce employment and training programs and determine their impact on employment and unemployment both in the short-run and the long-run. The theoretical model identifies those program characteristics which are important in affecting employment and unemployment: (1) the extent to which the program is targeted at a particular group, e.g., the unemployed, low income, etc.; (2) the placement rates of individuals leaving the program; (3) the scale of the program; (4) the timing of the program; and (5) whether or not the program changes the participants' longer-term labor market success. Using these factors, it was predicted that the impact of spending $500 million more on youth employment programs would mean a reduction in unemployment rates of between 0.1 and 0.9, depending on the assumptions made. The study laid the foundation for future examination of these issues with manipulation of different variables. (KC)

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THE POTENTIAL IMPACT OF EMPLOYMENT AND TRAINING PROGRAMS ON YOUTH UNEMPLOYMENT

by

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INTRODUCTION

Teenage unemployment has been at high levels in the United States in recent years. Explanations for this fact vary. Some contend that the measured rates are misleading because full-time students are included. Others suggest that minimum wage laws curtail demand for teenage labor. Still others point to high rates of voluntary turnover among young people who "job shop" early in their career.

Concern about the high unemployment rates of teenagers, particularly blacks in urban areas has prompted the passage of the Youth Employment Demonstration Projects Act of 1977. This law creates new youth programs and expands funding for existing employment and training programs serving youth.

This paper addresses the question of what impact this expansion of employment and training program for youth is likely to have on employment and unemployment of young people. The method used in the analysis will be to specify a model of the youth labor market which focuses on turnover flows between employment, unemployment, and school and, then, to introduce employment and training programs and determine their impact on employment and unemployment both in the short-run and the long-run. The turnover model will be similar to the Markov model discussed in Toikka (1976).

The theoretical model will identify those program characteristics which are important in affecting employment and unemployment. The following program characteristics will be evaluated in the model: (1) the extent to which the

program is targeted at a particular group, e.g., the unemployed, low income, etc.; (2) the placement rates of individuals leaving the program; (3) the scale of the program; (4) the timing of the program; and (5) whether or not the program changes the participants longer term labor market success.

Inferences will be drawn about the impacts of previous employment and training programs on youth unemployment. This analysis will be similar in objective to the analysis conducted by Small (1972); however, the data will be interpreted in light of the theoretical model described above. Finally, based on present knowledge of the parameters of the labor market model and the program characteristics of the expanded youth programs, projections will be made of the impact of these programs on youth unemployment in 1978-9.

I. ISSUES

A. Net Job Creation

An important determinant of a program's impact on employment and unemployment is the extent to which <u>new</u> jobs or training slots are created. In general, there are two methods by which federal employment and training appropriations have impacts on the number of jobs in a community. First, the federal government may directly run programs either by using government facilities and personnel or by contracting with private firms to manage programs. The Job Corps is an example of such direct federal intervention. Second, the federal government may make grants available to states and localities for the purpose of funding programs. The programs funded under Titles I, II, and VI of the Comprehensive Employment and Training Act are exmples of the federal grant approach to funding

programs. Either approach may be used to create subsidized jobs in the public or private sector.

Federal grants lead to an increase in job or training slots only if the federal funds do not replace state and local funds which would have been spent if the federal grant was not available. The process by which federal funds replace state and local funds is known as fiscal substitution. The consensus among economists who have studied this process is that fiscal substitution is more likely when grants place few restrictions on the use of federal funds. However, the process is likely to be quite complex, depending on a number of factors such as the preferences of state and local governments for types of programs, the size of the federal grant, requirements as to state and local contributions, and restrictions on the use of the federal money. Also, fiscal substitution effects are likely to be spread out in time.[1]

Let us consider how this process might operate in a CETA funded Title VI project. Suppose a grant is made to a city prime sponsor to run a training program for high school dropouts. Now suppose the city already has a state funded program which employs unemployed youth. It is possible that the city would decide to discontinue the state funded program, once the federal CETA program was established. In practice, the phasing out of the state funded program might be gradual, not occurring until the next funding cycle, etc. But if the pattern of state and local expenditure is observed over a sufficiently long time and other factors do not intervene, the fiscal substitution may show up in reduced state and local expenditures. However, the process may be harder to detect than in this simple example. Suppose a state or locality is expanding its expenditures by 5% each year. Then, in the year following the influx of federal CETA funds, state and local expenditures grow by only 2%. To what

extent can the slowdown in the growth of the state and local sector be attributed to the federal grants? We cannot answer this question unless we know what the change in state and local expenditure would have been in the absence of the federal grant. If, in fact, the increase would have been 5% and the rate drops to 2% then fiscal substitution reduces the rate of growth of state and local government spending by 3 percentage points.

Fiscal substitution causes a reduction in state and local expenditure below what it would have been in the absence of the federal grant. The reduction in state and local spending may be distributed through time. Accompanying these reductions will be either (a) an increase in the state and local current account surplus, (b) a reduction in debt, or (3) a reduction in taxes. The first result would create no jobs. The second might create jobs indirectly by transferring resources to bond holders and by possibly lowering interest rates and stimulating private investment (however, these effects are likely to be slow and diffused). The third result would create jobs by stimulating private consumption demand--these impacts are also likely to be diffused but not as much as the impact of the debt reduction.

If, in the long run, the effects of fiscal displacement are to reduce taxes or retire debt, then the loss of public sector jobs is to some extent offest by the creation of new jobs in the private sector. The major disadvantage to the reallocation of jobs from the public to private sector seems to be that the targeting aspect of the public jobs program is defeated since the preferences of private employers dictate who is hired in the private sector jobs.

However, the public employment of target groups may be somewhat protected from the attrition inherent in fiscal substitution. If state and local

governments increase their employment of members of a target group and reduce employment of other groups, then there may be a permanent shift in the proportion (and absolute numbers) of the target group employed in the public sector.

To summarize, fiscal substitution occurs when a state or locality substitutes federal money for money which it would have spent in the absence of the federal grant. The effect of fiscal substitution is to reduce state and local expenditures relative to what they would have been if the federal grant had not been offered. This effect shows up in a reduced level or rate of growth of state and local expenditure over time if other factors do not intervene.

In addition to fiscal substitution of federal for non-federal funds, another type of substitution may occur if the federally funded program has a target group. State and local sponsors may decide to shift members of the target group who would otherwise have been in state and local programs into federally funded programs. The result of this substitution may be to reduce the number of new jobs created for members of the target group. This employment substitution may occur even if fiscal substitution does not occur. For example, suppose that a city would have employed 250 disadvantaged, unemployed youth without a CETA program. If the CETA program creates 250 job or training slots, it is possible that the city may find a way of transferring the 250 employees into the CETA program and replacing them with workers who are not disadvantaged, unemployed youth.

While fiscal substitution reduces the total number of new jobs created by a federal grant, employment substitution reduces the number of new jobs created for members of a target group such as disadvantaged youth. Both of these effects can limit the effectiveness of federal grants in creating new subsidized

job or training slots. In theory, these effects apply equally well to subsidized jobs in both the private and public sectors. A prime sponsor could substitute a federally funded project for a locally funded program to create private sector jobs as well as for a locally funded project with public jobs. Consequently, the effects of fiscal and employment substitution should be viewed as broadly constraining the effectiveness of federal grants to increase the number of private and public jobs.

There are ways in which federally funded programs can affect the number of jobs in the private sector independently of the fiscal and employment substitution just discussed. If the federal projects compete with private activities, there could be a cutback in employment in the private sector. Such displacement effects are unlikely if the federal projects are designed to expand goods and services in the public sector such as education. Second, there is the possibility that subsidized employment and training programs could attract labor away from private employers causing them to incur increased costs in the form of either higher wages, greater expenditure on search activity, or lost output due to increased duration of job vacancies. One response of employers might be to cut back employment reducing private sector jobs. How likely this contraction in non-subsidized private employment is depends on whether the hiring behavior of private employers is affected by the existence of subsidized jobs and on whether firms respond to labor shortages by reducing the number of jobs.

If the subsidized jobs are narrowly targeted for individuals who are unlikely to be hired into private sector jobs, then disruption of private employers hiring behavior is also unlikely. Even if private employers do experience labor

shortages, their response may be to raise wages rather than to cut back employment. This wage inflation has actually been touted as a desirable impact of public employment programs by some observers because it raises wages in low skill jobs.[2]

To summarize, there are reasons for thinking that some contraction in demand for labor in the private sector may occur in response to new subsidized jobs. The effects occurring through direct competition between subsidized activities and non-subsidized activities can be kept at a minimum by focusing the subsidized activities on expansions of public services or activities which do not substitute for activities of private firms. Those occurring through labor shortages resulting from the subsidized jobs can be minimized by targeting the subsidized jobs for individuals not likely to be hired in the private sector.

B. Impacts on Labor Force Participation

The fiscal and employment substitution effects in the public sector together with responses by private firms determine how many new jobs are created and the individuals that are hired into those jobs. In general, a subsidized program will create new jobs even though the number of new jobs may be less than the number funded under the program. The increase in the number of jobs may increase the number of individuals in the active labor force (i.e., employed or looking for work).

The increase in labor force participation may occur in either of two ways. First, it may occur directly if the subsidized program takes in individuals who would not have been in the labor force. An increase in the measured labor force would result directly in most cases because participants in most employment and training projects are counted as employed. Second, the rise in labor force

participation could occur indirectly as a result of improvements in job prospects in the local labor market.

This indirect effect occurs when the subsidized program takes in individuals who would have been employed or unemployed if not in the subsidized program. When persons who would have held other jobs are taken into the program, there is an increase in job vacancies outside of the program. Similarly, when persons who would have been unemployed are inducted, there is a reduction in unemployment. The resulting increase in the ratio of job vacancies to job seekers improves the prospects of any given job seeker for getting a job. This improvement in labor market conditions from the point of view of the job seeker (the labor market becomes more of a seller's market) may attract more people into the active labor force.[3]

If labor force participation increases in response to the subsidized program for either of the above reasons, the increase in employment will exceed the reduction in unemployment.

C. Program Characteristics

Certain characteristics of employment and training programs affect impacts on the total number of jobs created, the allocation of these jobs to target groups, and the number of unemployed.

Job creation will be dealt with first. As indicated in section A, fiscal substitution is reduced when projects are defined so that they are poor substitutes for projects that would have been undertaken in the absence of the federal grant. This reduction in fiscal substitution means more "bang" for the federal "buck" in creating jobs. Similarly, the incentive for state and local governments to shift members of a target group off of projects funded by non-federal sources and on to projects funded by federal money is reduced if the federally funded project is targeted for the long-term unemployed (or those out of the labor force). If those admitted to the federally funded programs are required to have been out of work for a length of time, this requirement makes it difficult for employment to be shifted from projects funded by non-federal money to those funded with federal money, since any individuals displaced from the former projects would have to be out of work for a length of time before qualifying for the latter projects. It may be easier for this type of substitution to occur when the state and local sector is expanding. In this case, the transfer of members of the target group to federally funded projects could be accomplished by not hiring target group members in new projects funded by non-federal funds. The unemployed not hired in the new state and local projects would then be eligible for the federally funded projects.

A number of other program characteristics affect the success of the job creation effort. The size of the federal grant (combined with state matching

funds if appropriate) together with the fiscal substitution effects, the labor intensity of the projects, and the average wage rate will determine the number of new jobs created. Other factors equal, more jobs will be created by labor intensive projects and by low wage projects.

Program characteristics are also important in determining what impact the increase in the number of jobs has on unemployment and labor force participation. The following are particularly important: (1) the target group for the program and how effectively the program impacts on the target group, (2) the duration of job or training slots, (3) the job placement rates of individuals after termination from the program, (4) program dropout rates and the reasons for non-completion, (5) the program's effectiveness in changing the frequency and duration of an individual's future unemployment. Each of these factors will now be discussed briefly.

Targeting. Programs can be targeted in a variety of ways. The programs run under CETA are generally targeted for the unemployed, underemployed, and economically disadvantaged. The data on enrollees in CETA programs reveal that Title I enrollees are more likely to be young, economically disadvantaged, or members of minority groups, then those enrolled under Titles II and VI.[4] Title III authorizes a series of programs for special groups, the most important of which for the youth population is the Summer Youth Employment Program. This program is targeted at economically disadvantaged youth aged 14 to 21. Generally, it will be true that a program will have a larger impact on measured unemployment, if it takes in those who are unemployed or likely to become unemployed. A program can have a large fraction of enrollees who would have been unemployed if it has been explicitly targeted on the unemployed, or if it has been targeted on groups such as youth from low income families who have high unemployment rates.

Duration. The length of time enrollees spend in the program will partly determine the aggregate impact of the program. The total number of jobs created can be multiplied times the average duration of a participant in the program to get a measure of total person-years in the program. This measure of total person-years is the relevant measure for determining the impact of the program on measured unemployment. Some fraction of the total person-years in the program would have shown up as person-years of unemployment in the absence of the program.

Job Placement. While the initial impact of a program can be gauged from the pre-program labor force status of the enrollees, and the duration of the program, eventually the enrollees must terminate from the program and have an impact on measured unemployment. To the extent that program terminees find jobs, the flow of persons out of the program will not contribute to measured unemployment. However, to the extent that they do become unemployed jobs seekers after leaving the program, they will increase unemployment. Other factors equal, a program with a high job placement rate will contribute to a larger reduction in unemployment than a program with a low placement rate. Data on placements must be interpreted with care. Current CETA statistics make the distinction between "positive" and "negative" terminations.[5] Positive terminations include transitions into jobs but also include transfers to other programs and entrance into school. These transfers should be netted out to get a true measure of job placements.

Dropouts. Dropouts from programs are important for the same reasons that other terminations are. The post-program labor force status of dropouts affects the program's impact on measured employment. Dropouts pose more of a measurement problem than completers because follow-up information is usually worse for dropouts than for program completers.

Impact on Future Unemployment. To the extent that a program is successful in improving the future labor market experiences of its participants, it will have a larger impact in reducing unemployment. These effects will be spread out through time, but should be observable if they are large enough and if a program remains in place for a long enough time. The longer a program remains in place, the larger is the fraction of the target group that has received program treatments. Since treated individuals ought to have lower unemployment rates than untreated individuals, the average unemployment rate should be lower than it would be in the absence of the program. This effect is likely to be smaller for an age cohort such as youth (16-24) since the fraction of people leaving the cohort as they "age" (turn 25) who have been treated will be greater than the fraction of entrants into the cohort (who turn 16) who have been treated. This attrition of treated individuals will diminish the program's impact on unemployment, but not eliminate it entirely.

To summarize, the characteristics of an employment or training program influence its impact on measured unemployment. Restrictions on the use of federal funds and targeting employment for the unemployed help to reduce fiscal and employment substitution which if unchecked could work to defeat the objective of the federal grants in creating jobs for special groups. The size of the net increase in expenditures combines with the degree of labor intensity of the funded projects and the average wage rate to produce the increase in jobs attributable to the federal grant. The process by which the increase in jobs gets translated into impacts on unemployment also depends on program characteristics. Particularly important in determining the impact on unemployment are the targeting of the program for particular groups, the duration of time spent in the program by participants, the job placement and dropout rates of the program, and the effectiveness of the program in reducing the frequency and duration of future unemployment.

D. Timing of the Impacts

The processes which have been described in the preceding sections will be spread out in time. A full dynamic analysis of the total impact of a program on the local labor market would involve specifying the timing of each of the relevant processes. Since our knowledge of the timing of these responses is very limited, a better approach may be to refer more crudely to short-term impacts and longer term impacts. There are reasons to think that the short-term impacts will reduce unemployment and then this reduction in unemployment will be eroded somewhat by longer term indirect impacts.

The literature on public sector response suggests that fiscal substitution may not occur immediately. If this is so then the short-term impact of a federal grant may be to increase the number of jobs by the full number of new slots created in the federally funded program. If employment substitution similarly lags behind the initial impact, the short-run impact may be to increase jobs for the target group by the full number of slots in the new program.

The discussion in section B on labor force participation suggests that it may be useful to separate the induced changes in labor force participation into two categories: (a) those occurring directly because the program takes in individuals who would have been out of the labor force and (b) those occurring because of an improvement in labor market conditions which alters behavior and causes more people to enter the labor force (or to remain in the labor force). The first effect is direct and immediate. The second is indirect and probably takes more time to develop.

Another distinction that can be made is between the short-term impacts occurring during the build-up period in which the program is taking in enrollees but none have yet been terminated from the program and the longer term impacts

which occur when the program has matured and is both taking in and terminating individuals. The short-term impact on unemployment will be larger than the longer-term impact unless the program participants never become unemployed immediately after leaving the program.

Based on the above considerations, a short-run program impact can be analyzed under the assumptions of no fiscal or employment substitution and no changes in labor force participation except as produced by direct flows into the program by people out of the labor force and no termination from the program. The longer term impacts can then be analyzed by relaxing these assumptions. There is reason to think that the fiscal displacement effects may take the longest time to work through, particularly, if state and local projects are phased out by attrition. Thus, a medium-term analysis of impacts might assume no fiscal or employment substitution (or minimal effects), and focus on the effect of termination from the program and changes in labor force participation. Then, a long-term analysis might focus on the combined effects of fiscal and employment substitution, terminations from the program, and changes in labor force participation behavior.

The data analysis which is undertaken in section III of this paper will be to estimate the impact of an expansion in employment and training programs on equilibrium unemployment abstracting from the issues of fiscal substitution in the public sector, loss of jobs in the private sector, and changes in labor force participation in response to improved job opportunities. In the sense that the analysis does not deal with all of the impact issues, it is a partial analysis. It lays the foundation for a total analysis which will not be presented in this paper.

II. A MARKOV ANALYSIS OF PROGRAM IMPACT

On the basis of the considerations set out in section I, it is possible to identify eleven factors which affect the magnitude of a program's impact on unemployment. These factors are (1) the size of the federal grant (in dollars), (2) the overhead rate of the project, (3) the average wage on training allowance, (4) hours per week spent in the program, (5) the average duration of time spent in the program, (6) the distribution of enrollees by pre-program labor force status, (7) the distribution of terminees by post-program labor force status, (8) the normal turnover flows in the target population, (9) the extent of fiscal substitution, (10) the extent of sectoral displacement, (11) the resposne of labor force participation to changed local labor market condtiions, and (12) whether participants in the program are classified as employed, unemployed, or not in the labor force.

The task of this section is to specifiy a mathematical model which is consistent with the considerations discussed in section I. The program will be assumed to be in flow equilibrium in the sense that the intake flow per period (f^I) equals the flow of terminations (f^t). The steady state number of program participatns will be denoted by G. For a program with a stock of G participants, the outflow can be determined from the average per period probability of leaving the program (P_{GO}).[6] This relation is:

$$f^t = G\ P_{GO} \tag{1}$$

The flow equilibrium condition is then

$$f^I = f^t \tag{2}$$

Equations (1) and (2) give the relation between the stock and flows for a program in equilibrium.

The model development will be discussed in three stages. First, the factors which affect the equilbrium stock of particpatns (G) will be identified and discussed. It will be possible to represent the relation between G and the first four factors listed above in mathematical terms. Next, the factors affecting the flow through the program will be discussed. Third, the consequences of introducing the program as an additional state in a Markov probability model of the labor market will be analyzed. The resulting equilibrium stocks of employment and unemployment will then be derived and compared with the initial equilibrium before the program intervention.

Determination of the Stock of Program Particpants

In this section, the process by which federal spending creates new employment is described and a simple mathematical model of that process is developed. Suppose a federal grant of F dollars per year is spent on an employment or training proram. Ignoring the effects of fiscal substitution and crowding out of private jobs for the moment, the impact of the grant on employment will depend on the overhead rate and the average wage. If the fraction of total expenditures that is not paid out in wages to the target group is denoted by 0 and the average hourly wage or training allowance is denoted by W, the relation between the federal grant (F) and the total annual hours of employment or training paid for by the grant (H^G) is

$$H^G = F\,(1 - 0)/W \tag{3}$$

If the program is in place for the entire year and participants spend h hours per week in employment or training, then the total hours per slot per year is h^*

$$(4) \qquad h^* = 52 \times h$$

The number of employment or training slots (G) is then

$$(5) \qquad G = H^G/h^* = F\ (1 - 0)/wh \times 52$$

While G is the total number of job (or training) slots created by the federal grant, not all of these will be net new positions. Some will substitute for jobs that would have existed without the new program (e.g., fiscal substitution or sectoral displacement). If the number of jobs for which the program slots substitute is denoted by J, then the net job creation (NJ) by the program is

$$(6) \qquad NJ = G - J = (F(1 - 0)/wh \times 52) - J$$

Determination of Entrance and Exit Flows

If the program operates so as to spend all of its federal grant, the number of job slots will all be filled and G will also be the number of persons in the program per period. The relation between the stock of paticipants and the number of persons entering and leaving in a period is given by equation (1) and (2). To determine the equilibrium flows, the termination probability (P_{GO}) is required.

Termination from a manpower program is never fully under the control of the program administrators. The program establishes an employment or training plan for an enrollee, whether the enrollee quits or is discharged prior to

completing depends at least partly on individual behavior and attitudes. If the program length of stay is ℓ, then in a steady state the termination probability for completing will be $1/\ell$. Suppose that the probability of a non-completer leaving the program in a given period is P^d, then the average length of stay for dropouts (q) will be $1/P^d$. The average exit probability over both completers and non-completers will be

$$P_{GO} = m\frac{1}{\ell} + n\frac{1}{q} \tag{7}$$

where m is the fraction that are completers and n, the fraction that are dropouts.

Substitution of (7) and (2) into (1) gives the relation between the stock and flows:

$$f^t = f^I = G\left(m\frac{1}{\ell} + n\frac{1}{q}\right) \tag{8}$$

Further substitution of (5) into (8) gives the relation between the flows and all of the factors which have been discussed above:

$$f^t = f^I = F(1 - 0)\left(m\frac{1}{\ell} + n\frac{1}{q}\right)/wh \times 52 \tag{9}$$

Determination of Labor Market Equilibrium

Having traced through the impact of a federal grant on the number of participants, the gross flows into and out of the program, and the total stock of jobs plus training slots, we are now in a position to analyze the program's impact on the labor market. The labor market prior to the introduction of the program will be described by a Markov process with three states: employment, unemployment, and non-participation in the labor force. Denote the probability

of transition from state i to state j by P_{ij} and the steady state probability of being in state i by Π_i. The steady state equilibrium is then described by

(10) $$\underline{\Pi} = \underline{\Pi}\,\underline{P}$$

where $\underline{\Pi} = (\Pi_E \; \Pi_U \; \Pi_N)$

$$\underline{P} = \begin{pmatrix} P_{EE} & P_{EU} & P_{EN} \\ P_{UE} & P_{UU} & P_{UN} \\ P_{NE} & P_{NU} & P_{NN} \end{pmatrix}$$

and $\sum_j P_{ij} = 1$ for all i

where E, U, and N denote employment, unemployment and not in the labor force. For a given matrix $\underline{P}$ the equilibrium state vector may be determined uniquely.

A manpower program may be introduced into this model by defining an additional state G, and a new state vector $\Pi^* = (\Pi_E^* \; \Pi_U^* \; \Pi_N^* \; \Pi_G^*)$ and transition matrix $\underline{P}^*$.

(11) $$\underline{P}^* = \begin{pmatrix} P_{EE}^* & P_{EU}^* & P_{EN}^* & P_{EG} \\ P_{UE}^* & P_{UU}^* & P_{UN}^* & P_{UG} \\ P_{NE}^* & P_{NU}^* & P_{NN}^* & P_{NG} \\ P_{GE}^* & P_{GU}^* & P_{GN}^* & P_{GG} \end{pmatrix}$$

The first three elements of the new state vector may then be compared with the elements of the old state vector $\underline{\Pi}$, to see the impact of the program on the distribution of persons by labor market state.

In order to derive the new transition matrix $\underline{P}^*$, the following information is required: (1) the transition probabilities out of the program (P_{GE}, P_{GU}, and P_{GN}), (2) the transition probabilities into the program (P_{EG}, P_{UG},

and P_{NG}), and (3) the post-program values for the nine transition probabilities of the three state labor market model. Each of these will now be discussed.

The transition probabilities for the transitions out of the program into the three other labor market states are determined by the probabilty of leaving the program P_{GO}, the derivation of which has been discussed earlier, and the distribution of the exit flow between the three other labor market states. If the fraction of the total flow out of the program going immediately into state i is denoted by Z^i, then the three exit transition probabilities may be written as

$$(12) \qquad \begin{aligned} P_{GE} &= Z^E \; P_{GO} \\ P_{GU} &= Z^U \; P_{GO} \\ P_{GN} &= Z^N \; P_{GO} \end{aligned}$$

The stayer transition P_{GG} is determined from the identity

$$(13) \qquad P_{GG} = 1 - P_{GE} - P_{GU} - P_{GN}$$

The transition probabilities for transitions into the program may be determined using information on the following: (1) the total flow into the program in any period, (2) the fraction of the flow coming from each of the three labor market states, (3) the stock of people in each labor market state.

The total flow into the program can be determined for a program in equilibrium using equation (2). If the fraction of flow coming from state i is denoted by S^i, and the number of people in the labor market state of employment, unemployment, and not in the labor force are denoted by E, U, and N, respectively, the entrance transition probabilities can be written as

$$P_{EG} = \frac{f^{I_S}E}{E}$$

(14) $$P_{UG} = \frac{f^{I_S}U}{U}$$

$$P_{NG} = \frac{f^{I_S}N}{N}$$

Finally, the post-program matrix of transition probabilities for the three labor market states (E, U, and N) may be determined if it is known how the introduction of the program affects those transition probabilities. The assumption which will be made is that the probability of a person in state i entering the program is independent of the probabilities of entering any of the other states. On this assumption, the post-program transition probability P^{*}_{ij} may be written as

(15) $$P^{*}_{ij} = P_{ij}(1 - P_{iG})$$

This assumption implies that all of the elements in a given row of the pre-program transition probability sub-matrix are reduced by the same proportion (multiplied by $(1 - P_{iG})$ which is the same for a given row).

With these assumptions, the four state Markov process may be solved for the post-program equilibrium values of E, U, and N. These post-program values may then be compared with the pre-program values to obtain estimates of program impact on the labor market.[7]

The effects of fiscal displacement, sectoral displacement, and changes in labor force participation may then be introduced to obtain an estimate of total program impact.

III. DATA ANALYSIS

In this section, the Markov model described in section II will be applied to determine the impacts of programs with different types of characteristics. To describe the national labor market for young people, Current Population Survey data on monthly gross changes in labor force status are used. The year 1977 is taken as a base year in determining what the impact of programs might be. The labor market equilibrium for 1977 is estimated using CPS data. Then programs of hypothetical size and characteristics are introduced and their impact on the labor market equilibrium assessed.

At the time this paper was written, data on gross changes in labor force status for young people was available up through September 1977.[8] To estimate the equilibrium distribution of youth by labor force category for 1977, an approximate procedure was used. First, the average monthly probabilities of changing labor force state for 1976 were calculated for each of eight demographic groups created by stratifying the sample into two age groups (16-19, 20-24), two sex groups, and two race groups (white, non-white). These probabilities were then adjusted to approximate 1977 values by multiplying each probability by the 9 month (January-September) average of the ratio of the 1977 transition probability to the 1976 transition probability. In general, the economic situation improved from 1976 to 1977 so that unemployment dedecreased and employment increased for the groups. In Appendix A, the average 1976 monthly transition probabilities for each of the eight groups are reported along with the adjustment factors and the estimated 1977 transition probabilities. In Table 1, the estimated average 1977 transition probabilities for the eight groups are reported. The equilibrium state distributions

TABLE 1

ESTIMATED AVERAGE TRANSITION PROBABILITIES
FOR EIGHT DEMOGRAPHIC GROUPS FOR 1977

	Transition Probability*								
Group	EN	EU	EE**	NE	NU	NN	UE	UN	UU
White Females 16-19	.106	.033	.861	.102	.069	.829	.274	.288	.438
White Females 20-24	.046	.020	.934	.074	.052	.873	.290	.239	.471
White Males 16-19	.094	.043	.863	.144	.082	.774	.303	.260	.436
White Males 20-24	.029	.030	.941	.159	.086	.755	.345	.111	.545
Non-White Females 16-19	.152	.055	.793	.044	.076	.880	.150	.455	.395
Non-White Females 20-24	.058	.036	.906	.060	.094	.845	.140	.322	.538
Non-White Males 16-19	.169	.072	.759	.092	.101	.807	.165	.380	.455
Non-White Males 20-24	.042	.051	.907	.110	.120	.770	.190	.146	.664

*The transition from state A to state B is denoted by AB where A and B can take on values E, U, and N representing employment, unemployment, and not in the labor force, respectively.

**The stayer transition probabilities were computed by subtracting the sum of the two mover transition probabilities from one, so that the rows of the Markov matrix sum to one.

that are produced by solving a Markov process with those transition probabilities are given in Table 2 along with the actual annual averages for 1977 as reported by BLS.[9]

The discrepancies between the equilibrium values and the reported BLS values are large enough to cause some concern. There are three possible explanations for the discrepancies. First, the labor market in 1977 could have been out of equilibrium so that the equilibrium and actual values are different. Second, the adjustment procedure which was used in arriving at 1977 transition probabilities may have been deficient because of the missing data for the last three months. Third, the equilibrium values computed from the transition probabilities may be inconsistent with the data from the full CPS because the gross change data are based on a subsample of the full CPS sample.

The last explanation deserves further discussion. The gross change data are based on approximately two-thirds of the total CPS sample. One-quarter of the CPS sample households drop out of the sample in each month and are replaced by new households. Since it is impossible to interview members of the households which enter and leave for two consecutive months, only three-quarters of the sample may be used in matching identical persons from one month to the next. In addition, some of the households are not successfully re-interviewed even though they are in the sample frame. As a result, the gross change data are based on only a portion of the full CPS. Because the gross change sample is a subsample of the CPS, there is no guarantee that the gross changes in that subsample will be consistent with the observed changes in the full CPS.

The explanation for the observed discrepancy between the equilibrium and actual distributions will not be pursued further here. It is not crucial to

TABLE 2

MARKOV EQUILIBRIUM AND ACTUAL VALUES FOR
EMPLOYMENT AND UNEMPLOYMENT IN 1977*
(Thousands)

		Markov Equilibrium			Actual		
Sub-Group	Population	Employment	Unemployment	Unemployment Rate	Employment	Unemployment	Unemployment Rate
WM 16-19	6,962	3,932	646	14.1	3,824	699	15.4
WM 20-24	7,985	6,357	611	8.8	6,286	684	9.8
WF 16-19	7,017	3,376	580	14.7	3,222	639	16.6
WF 20-24	8,375	5,161	472	8.4	5,112	544	9.6
NM 16-19	1,204	378	175	31.6	329	198	37.6
NM 20-24	1,188	724	203	21.9	725	211	22.5
NF 16-19	1,287	282	135	32.4	261	173	39.9
NF 20-24	1,464	664	178	21.1	656	206	23.9

*Employment, Unemployment, and Population figures are rounded to the nearest whole number.

the major purpose of this paper that the equilibrium values be very close to the actual values. If the reader wishes, he may interpret the equilibrium values as hypothetical and interpret the results that follow as being the impact that employment and training programs have on that hypothetical equilibrium. The values of the transition probabilities used to create the labor market environment prior to the introduction of the program(s) were selected to approximate the conditions existing for youth in 1977. More refined estimation of those transition probabilities would not substantially alter the results of the impact analysis since the concern is primarily with the change in the equilibrium that results from the introduction of new programs rather than the level of the new equilibrium.

The first type of empirical analysis presented here is an analysis of the relation between the number of program job or training slots (G) and the following variables: the federal grant (F), the average hourly wage rate (W), the fraction of the grant going to non-wage expenditures (0), and the number of hours per week spent in the program per participant (h). In Table 3, a range of values for number of job/training slots (rounded to the nearest whole number) are given corresponding to a number of assumptions about 0, W, and h for a federal grant of a million dollars per year. As can be seen in Table 3, a million dollars produces anywhere from 130 to 1,306 job training slots. The two extreme values correspond to extreme estimates about hours per week, wage, and overhead rates. The 1,306 slots were generated by a program with minimal hours per week (5), low overhead (10%), and minimum wage ($2.65), while the 130 slots were generated by a program which offered full-time slots (40 hours per week), a higher overhead rate (20%), and a higher wage ($2.90).

TABLE 3

NUMBER OF JOB/TRAINING SLOTS CREATED BY A FEDERAL GRANT OF ONE MILLION DOLLARS*

Assumption	Job/Training Slots	Overhead Rate	Hourly Wage	Hours per Week
1	1,306	10%	$2.65	5
2	327	10%	$2.65	20
3	163	10%	$2.65	40
4	1,194	10%	$2.90	5
5	298	10%	$2.90	20
6	149	10%	$2.90	40
7	1,161	20%	$2.65	5
8	290	20%	$2.65	20
9	145	20%	$2.65	40
10	1,061	20%	$2.90	5
11	265	20%	$2.90	20
12	133	20%	$2.90	40

*Assumes no substitution of grant funds for other funds.

The labor market simulations which are reported in the remainder of the paper will be based on assumption set number 2: 20 hours per week, 10% overhead rate, and minimum wage in the context of a federal grant of 500 million dollars. This federal outlay is assumed to be an increase over what was spent in 1977. The labor market impact of such an outlay will now be examined.

Setting aside issues of whether the jobs created by the federal grants replace jobs that would have existed in either the public or private sector for the moment, it can be seen that under assumption set 2 the federal grants produce 163,280 job/training slots.[10] The impact of such a permanent program on the labor market for youth will now be determined under a variety of assumptions about the targeting of the program and the average length of stay in the program.

The notation used here will be identical to that of section II. The variables defined there and the relations among them will be briefly reviewed here before presenting the empirical results. The key variables are:

- G = number of program slots
- l = length of stay in the program
- f^I = total monthly flow of persons into the program
- f^t = total monthly flow of persons out of the program
- S^i = the fraction of the entry flow (f^I) which comes from state i
- Z^i = the fraction of the exit flow (f^t) which enters state i
- P_{ij} = the probability of transition from state i to state j before the program's introduction (i = E, U, N)
- P_{G0} = the probability of leaving the program in each month
- P_{Gi} = the probability of transition from the program into state i (i = E, U, N)
- P_{iG} = the probability of transition from state i into the program (i = E, U, N)
- Π = the Markov state vector before the program is introduced (1 x 3)
- Π^* = the Markov state vector after the program is introduced (1 x 4).

The equations relating these variables and vectors are summarized in Appendix B. A separate Markov process may be defined for each demographic group, so that there will be one set of the variables defined above for each group. For the purposes of the simulations, the P_{ij} were assumed to be those given in Table 2. For all of the simulations, the length of stay in the program was assumed to be six months ($\ell = 6$).[11] The number of program slots (G) was set equal to 163,280. These slots were distributed across demographic groups in population to the size of their equilibrium labor force. The program was assumed to be constant in size so that the flow of entrants equaled the flow of terminees. These assumptions imply that $f^I = f^t = 27213$, and that $P_{G0} = 1/6$.

The assumptions that were varied in the simulations included: (1) the distribution of entrants by labor market state prior to entrance (S^i), (2) the distribution of program terminees by the labor market state they enter when they leave the program.

In the following table, the impact of the expanded manpower programs on the equilibrium distribution of individuals by labor force state is shown. The tables report the employment, unemployment, and unemployment rate which occur in the post-program equilibrium and the deviation of these values from the pre-program equilibrium values reported in Table 2. The impact on the unemployment rate is given under three assumptions about how program participants are classified: (1) out of the labor force, (2) employed, and (3) unemployed. The second assumption would be appropriate if the program provided jobs. The first or the third would apply if the program did not provide jobs. In the latter case, the program participants would be counted in the labor force only if they were looking for jobs.

TABLE 4

EMPLOYMENT AND UNEMPLOYMENT AFTER
THE PROGRAM IS IN PLACE

Simulation No. 1

$\ell = 6$ $\quad s^E = .2 \quad z^E = .6$

$s^U = .6 \quad z^U = .2$

$s^N = .2 \quad z^N = .2$

Group	G	EMP (in thousands)	UNEMP	UR1*	UR2	UR3	ΔUR1**	ΔUR2	ΔUR3
WM16-19	79	3,896	637	14.0	13.8	15.5	-0.1	-0.3	1.4
WM20-24	79	6,301	600	8.7	8.6	9.7	-0.1	-0.2	0.9
WF16-19	67	3,355	568	14.5	14.2	15.9	-0.2	-0.5	1.2
WF20-24	64	5,146	461	8.2	8.1	9.3	-0.2	-0.3	0.9
NM16-19	9	370	170	31.5	31.0	32.6	-0.1	-0.6	1.0
NM20-24	11	720	200	21.7	21.5	22.7	-0.2	-0.4	0.8
NF16-19	8	282	134	32.2	31.6	33.5	-0.2	-0.8	1.1
NF20-24	10	662	176	21.0	20.8	21.9	-0.1	-0.3	0.8

*UR1, UR2, and UR3 are the post-program unemployment rates with the program participants counted as out of the labor force, employed, and unemployed, respectively.

**ΔUR1, ΔUR2, and ΔUR3 denote the difference between the pre-program equilibrium unemployment rate in Table 2 and the post-program values of UR1, UR2, and UR3, respectively [ΔUR1 = UR1 - UR, where UR is the pre-program unemployment rate].

TABLE 4
(continued)

Simulation No. 2

$\ell = 6$ $\quad s^E = .2 \quad z^E = 1$

$s^U = .6 \quad z^U = 0$

$s^N = .2 \quad z^N = 0$

Group	G	EMP (in thousands)	UNEMP	UR1	UR2	UR3	ΔUR1	ΔUR2	ΔUR3
WM16-19	79	3,912	632	13.9	13.7	15.4	-0.2	-0.4	1.3
WM20-24	79	6,319	594	8.6	8.5	9.6	-0.2	-0.3	0.8
WF16-19	67	3,370	564	14.3	14.1	15.8	-0.4	-0.6	1.1
WF20-24	64	5,168	456	8.1	8.0	9.1	-0.3	-0.4	0.7
NM16-19	9	371	170	31.4	30.9	32.5	-0.2	-0.7	0.9
NM20-24	11	723	199	21.6	21.3	22.5	-0.3	-0.6	0.6
NF16-19	8	283	134	32.1	31.5	33.4	-0.3	-0.9	1.0
NF20-24	10	666	175	20.8	20.6	21.7	-0.3	-0.5	0.6

TABLE 4
(continued)

Simulation No. 3

$\ell = 6$ $\quad s^E = 0 \quad z^E = .6$

$\quad s^U = 1 \quad z^U = .2$

$\quad s^N = 0 \quad z^N = .2$

Group	G	EMP (in thousands)	UNEMP	UR1	UR2	UR3	ΔUR1	ΔUR2	ΔUR3
WM16-19	79	3,899	634	14.0	13.8	15.5	-0.1	-0.3	1.4
WM20-24	79	6,303	596	8.6	8.5	9.7	-0.2	-0.3	0.9
WF16-19	67	3,358	565	14.4	14.2	15.8	-0.3	-0.5	1.1
WF20-24	64	5,138	455	8.1	8.0	9.2	-0.3	-0.4	0.8
NM16-19	9	370	170	31.5	31.0	32.6	-0.1	-0.6	1.0
NM20-24	11	721	199	21.6	21.4	22.6	-0.3	-0.5	0.7
NF16-19	8	282	134	32.2	31.6	33.5	-0.2	-0.8	1.1
NF20-24	10	664	176	21.0	20.7	21.9	-0.1	-0.4	0.8

TABLE 4
(continued)

Simulation No. 4

$\ell = 6$ $\quad s^E = 0 \quad z^E = 1$

$s^U = 1 \quad z^U = 0$

$s^N = 0 \quad z^N = 0$

Group	G	EMP (in thousands)	UNEMP	UR1	UR2	UR3	ΔUR1	ΔUR2	ΔUR3
WM16-19	79	3,914	629	13.8	13.6	15.3	-0.3	-0.5	1.2
WM20-24	79	6,321	589	8.5	8.4	9.6	-0.3	-0.4	0.8
WF16-19	67	3,373	561	14.3	14.0	15.7	-0.4	-0.7	1.0
WF20-24	64	5,160	451	8.0	8.0	9.1	-0.4	-0.4	0.7
NM16-19	9	371	169	31.3	30.8	32.4	-0.3	-0.8	0.8
NM20-24	11	724	198	21.5	21.2	22.4	-0.4	-0.7	0.5
NF16-19	8	284	134	32.1	31.5	33.3	-0.3	-0.9	0.9
NF20-24	10	666	175	20.8	20.6	21.7	-0.3	-0.5	0.6

The importance of how the program participants are classified (e.g., employed, unemployed, etc.) stands out very clearly in Table 4. In simulation 1, the program's impact is to reduce the unemployment rate by anywhere from 0.1 to 0.2 percentage points if the participants are counted as out of the labor force and by anywhere from 0.2 to 0.8 percentage points if the participants are counted as employed. By contrast, if the participants are counted as unemployed, the unemployment rate actually increases by anywhere from 0.7 to 1.4 percentage points.

The importance of placing program terminees in jobs can be seen by comparing the impacts in simulation 1 with those in simulation 2. In simulation 1, 60 percent of the terminees enter jobs; in simulation 2, all of the terminees enter jobs. If the program participants are counted as not in the labor force, the unemployment rate reductions in simulation 1 range from 0.1 to 0.2 percentage points, while the reductions in simulation 2 range from 0.2 to 0.4 percentage points.

The importance of targeting a program on the unemployed can be seen by comparing the impacts in simulation 1 with those in simulation 3. In simulation 1, the program was assumed to take 60 percent of its participants from the unemployed pool, whereas in simulation 2, the program was assumed to draw all of its participants from the unemployed. If program participants are classified as not in the labor force, the program impact is to reduce a group's unemployment rate by anywhere from 0.1 to 0.2 in simulation 1 and anywhere from 0.1 to 0.3 in simulation 3.

When the program is assumed to take in <u>only</u> the unemployed and place <u>all</u> of its graduates in jobs, the reductions in the unemployment rate range from 0.3 to 0.4 (assuming that program participants are counted as being out of the labor force).

IV. CONCLUSIONS

This paper has presented a discussion of the issues relating to the impact of government manpower programs on youth unemployment. Preliminary empirical estimates of the possible impact of an increase in government spending of 500 million dollars (163,280 jobs or training slots) have been presented. These estimates are based on a Markov model in which the flow of individuals out of manpower programs equals the flow into those programs in each period. The impact of a program with specified characteristics on the distribution of individuals by the labor market states of employment, unemployment, and not-in-the labor force was determined. The impact of spending 500 million more dollars on youth manpower programs providing minimum wage slots for 20 hours per week with an overhead rate of 10 percent was a reduction in unemployment rates for the race, age, sex groups examined of between 0.1 to 0.9, depending on the assumptions made about targeting and job placement after termination from the program (if program participants are counted as either employed or not in the labor force). These estimates overstate the impact of such programs to the extent that they ignore the loss of jobs due to fiscal substitution and sectoral displacement. On the other hand, they may understate the longer-term impact, since they ignore any changes in future labor market experience which are caused by the program. The paper has laid the foundation for future examination of issues such as the impact of fiscal substitution and sectoral displacement on the number of jobs available and the long-term of manpower programs that may come about if the future labor market experiences of program participants are altered.

In future research, an attempt will be made to simulate the impact of actual manpower programs on the job market for youth. This will be done by estimating the values of parameters such as their length of stay in the program, and the fractions of the total participants entering from and departing to specified labor market states, and using the estimated values in Markov simulations.

APPENDIX A

Avergage Transition Probabilities and Adjustment Factors

Group and Transition Probability Type	WM16-19				WM20-24			
	1976 Average	x Adj. Factor	= 1977 Est. Ave.		1976 Average	x Adj. Factor	= 1977 Est. Ave.	
EN/E	.1008	.9350	.0942		.0279	1.0233	.0286	
EU/E	.0459	.9308	.0427		.0270	1.1103	.0300	
EE	.8533	1.0118	.8634	(.8631)*	.9433	.9962	.9397	(.9414)
NE/N	.1402	1.0243	.1436		.1516	1.0504	.1592	
NU/N	.0820	1.0045	.0824		.0940	.9102	.0856	
NN	.7778	.9989	.7770	(.7740)	.7544	.9911	.7477	(.7552)
UE/U	.2600	1.1657	.3031		.3082	1.1181	.3446	
UN/U	.2343	1.1119	.2605		.0956	1.1586	.1108	
UU	.5057	.9003	.4553	(.4364)	.5962	.8902	.5307	(.5446)
	WF16-19				WF20-24			
EN/E	.1136	.9348	.1062		.0500	.9226	.0461	
EU/E	.0315	1.0463	.0330		.0202	.9716	.0196	
EE	.8549	1.0074	.8612	(.8608)	.9298	1.0051	.9345	(.9343)
NE/N	.1069	.9536	.1019		.0717	1.0376	.0744	
NU/N	.0679	1.0194	.0692		.0515	1.0189	.0525	
NN	.8252	1.0066	.8307	(.8289)	.8768	.9774	.8570	(.8731)
UE/U	.2650	1.0357	.2745		.2482	1.1687	.2901	
UN/U	.2981	.9656	.2878		.2109	1.1343	.2392	
UU	.4369	1.0368	.4530	(.4377)	.5409	.8289	.4484	(.4707)

APPENDIX A
(continued)

	NM16-19				NM20-24			
	1976 Average	x Adj. Factor	= 1977 Est. Ave.		1976 Average	x Adj. Factor	= 1977 Est. Ave.	
EN/E	.1492	1.1340	.1692		.0392	1.0652	.0418	
EU/E	.0697	1.0341	.0721		.0477	1.0717	.0511	
EE	.7811	.9689	.7568	(.7587)	.9131	.9931	.9068	(.9071)
NE/N	.0748	1.2359	.0924		.1233	.8930	.1101	
NU/N	.0896	1.1252	.1008		.1269	.9432	.1197	
NN	.8356	.9616	.8035	(.8068)	.7498	1.0302	.7725	(.7702)
UE/U	.1601	1.0312	.1651		.1968	.9662	.1902	
UN/U	.3617	1.0492	.3795		.1643	.8870	.1457	
UU	.4782	.9529	.4557	(.4554)	.6389	1.0414	.6653	(.6641)
	NF16-19				NF20-24			
EN/E	.1777	.8546	.1519		.0610	.9568	.0584	
EU/E	.0688	.8034	.0553		.0311	1.1486	.0357	
EE	.7542	1.0567	.7970	(.7928)	.9079	.9977	.9058	(.9059)
NE/N	.0501	.8748	.0438		.0606	.9966	.0604	
NU/N	.0767	.9914	.0760		.0826	1.1404	.0942	
NN	.8732	1.0082	.8804	(.8802)	.8568	.9861	.8449	(.8454)
UE/U	.1234	1.2126	.1496		.1612	.8688	.1400	
UN/U	.3882	1.1728	.4553		.3538	.9110	.3223	
UU	.4884	.8226	.4018	(.3951)	.4850	1.1132	.5399	(.5377)

*Number in parentheses are derived by forcing the transition probabilities for the stayer flow (i.e., EE, UU, and NN) to equal 1 minus the two "mover" flows. In the simulations, the values in parentheses were used to assure that the rows of the Markov transition matrix summed to unity.

APPENDIX B

Summary of Variables and Equations in the Model

(1) $f^t = G\,P_{GO}$

(2) $f^I = f^t$

(3) $G = F(1-0)/(wh \times 52)$

(4) $P_{GO} = m\,\frac{1}{\ell} + (1-m)\,\frac{1}{q}$

(5) $P_{Gi} = Z^i\,P_{GO}$; $i = E, U, N$

(6) $P_{iG} = \frac{S^i\,f^I}{i}$; $i = E, U, N$

(7) $\underline{\Pi} = \underline{\Pi}\,\underline{P}$; $\underline{\Pi} = (\Pi_E\ \Pi_U\ \Pi_N)$; $\underline{P} = \{P_{ij}\}$

(8) $P^*_{ij} = P_{ij}(1 - P_{LG})$, all i, j

(9) $\underline{\Pi}^* = \underline{\Pi}^*\,\underline{P}^*$; $\Pi^* (\Pi^*_E, \Pi^*_U, \Pi^*_N, \Pi_G)$; $\underline{P}^* = \{P^*_{ij}\}$

Definitions

G = number of program slots

ℓ = length of stay of completers

q = length of stay of dropouts

m = fraction of terminations that are completers

f^t = monthly flow of terminations from the program

f^I = monthly flow of entrances into the program

S^i = fraction of the entry flow which comes from state i

Z^i = fraction of the exit flow which enters state i

P_{ij} = monthly probability of transition from state i to state j before the program's introduction

P_{GO} = probability of leaving the program in each month

APPENDIX B
(continued)

P_{Gi} = probability of transition from the program into state i

P_{iG} = probability of transition from state i into the program

Π = the Markov state vector before the program is introduced (1 x 3)

Π^* = the Markov state vector after the program is introduced (1 x 4)

APPENDIX C

The Solution of Markov Processes

In our research on labor markets we will be using the concept of flow equilibrium which can be represented by the steady state of a Markov process. Suppose that there are m labor market states of interest and at any point in time an individual must occupy one and only one state. This discussion will assume a discrete time process although there is a continuous time analogue. At discrete time intervals (say a month) transitions between states may occur. The probability of an individual moving from state i to state j will be denoted as p_{ij}. Let P be a mxm matrix of such transition probabilities such that

(1)
$$P = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1m} \\ p_{21} & p_{22} & & \\ \vdots & & \ddots & \\ p_{m1} & & & p_{mm} \end{bmatrix}$$

Let Π_{it} denote the probability that an individual will be in state i after the process has been observed for t periods from some starting point.* Let Π_t be a 1xm row vector of such elements

$$\Pi_t = (\pi_{1t}\ \pi_{2t} \cdots \pi_{mt})$$

This vector is called a state vector.

---

* The expected number of persons in a population of size T occupying that state i after t periods would then be expressed as π_{it} T if all individuals had the same transition matrix P.

The basic Markov transition relation is

$$\Pi_{t+1} = \Pi_t P \tag{2}$$

The Markov process is said to be in steady state equilibrium when a limiting state vector (Π) is reached such that**

$$\Pi = \Pi P \tag{3}$$

or

$$\Pi - \Pi P = \Pi(I - P) = \phi \tag{3'}$$

where I is the identity matrix.

If the matrix I-P were non-singular, the limiting state vector could be computed as

$$\Pi = (I - P)^{-1} \tag{4}$$

However, because the row elements of P sum to unity, the row elements of I-P sum to zero. The matrix I-P is singular because any one column can be expressed as a linear combination of the other m-1 columns.

However, the state vector can be determined by dropping one column from the matrix and using the resulting information to solve for the π_i elements to a factor of proportionality. All of the elements can then be obtained by using the identity

$$\sum_{i=1}^{m} \pi_i = 1 \tag{5}$$

** A process with a limiting state vector is called monodesmic. A sufficient condition for a process to be monodesmic is that all transition probabilities are non-zero. This condition is satisfied for all of the labor market models with which we will deal. See Howard (1971), p. 15.

This procedure can be illustrated by dropping the m^{th} column from the I-P matrix and partitioning the resulting matrix A in the following way

$$(6) \qquad A = \begin{bmatrix} 1-p_{11} & -p_{12} & \cdots & -p_{1m-1} \\ -p_{21} & 1-p_{22} & & \vdots \\ & & \ddots & \\ -p_{m-11} & -p_{m-12} & \cdots & 1-p_{m-1\,m-1} \\ - & - & - & - \\ -p_{m1} & -p_{m2} & \cdots & -p_{m\,m-1} \end{bmatrix} = \begin{pmatrix} A_1 \\ \hline A_2 \end{pmatrix}$$

The state vector is also partitioned so that

$$(7) \qquad \Pi = (\pi_1 \text{ --- } \pi_{m-1} \,\vdots\, \pi_m) = (\Pi \,\vdots\, \Pi_m)$$

Equation (3') may now be rewritten to represent a system of m-1 equations* as

$$(8) \qquad \Pi A = \Pi^* A_1 + \Pi_m A_2 = \phi$$

The solution for Π^* is then

$$(9) \qquad \Pi^* = -\Pi_m A_2 A_1^{-1}$$

with Π_m an unknown scalar. We acknowledge that we can solve for the state probabilities only to a factor of proportionality by pre-multiplying by Π_m^{-1} to get

*The solution to the system of m-1 linearly independent equations may be shown to be identical to the solution of the m equations with linear dependence. See Hadley (1961), pp. 170-171.

(10) $$\Pi_m^{-1}\,\Pi^* = -A_2\,A_1^{-1}$$

Alternatively, the state vector may be written as a vector of relatives:

(11) $$\Pi^{**} = \left(\frac{\pi_1}{\pi_m}\ \frac{\pi_2}{\pi_m}\ ---\ \frac{x_{m-1}}{x_m}\right) = \Pi_m^{-1}\,\Pi^*$$

and by substituting (10) into (11), we get

(12) $$\Pi^{**} = -A_2\,A_1^{-1}$$

The first m-1 elements of Π may be obtained from the elements of Π^{**} ($\pi_1^{**}, \pi_2^{**}, ---, \pi_{m-1}^{**}$) by using the identity (5) which implies that

(13) $$\sum_{i=1}^{m-1} \pi_i^{**} = \frac{1 - \pi_m}{\pi_m}$$

from which it may be seen that

(14) $$\pi_m = 1 + \sum_{i=1}^{m-1} \pi^{**}$$

Thus

(15) $$\pi_i = \pi_m\,\pi_i^{**} = \frac{\pi_i^{**}}{1 + \sum_{i=1}^{m-1} \pi_i^{**}}$$

The m^{th} element π_m may be obtained from

(16) $$\pi_m = 1 - \sum_{i=1}^{m-1} \pi_i = \frac{1}{1 + \sum_{i=1}^{m-1} \pi^{**}}$$

Footnotes

1. For further discussion of the displacement issues, the reader is referred to Fechter (1975) and Johnson and Tomola (1974).

2. For some evidence of the impact of government employment on low-skill wages, see Fogel and Lewin (1974) and Lewin (1974).

3. There is a large literature on the responsiveness of the size of the labor force to labor market opportunities and wages. For examples, see Bower and Finegan (1967), Mincer (1963), Smith (1977), and Toikka (1976).

4. See, for example, the Manpower Report of the President (1977), pp. 46-48.

5. See Ibid., p. 48.

6. The expected value of the flows is determined by the application of the exit probability to the stock. In the analysis presented here, the expectations operator is suppressed.

7. Since the transition probabilities in (14) depend on the equilibrium stocks (E, U, and N), the Markov process will be solved iteratively. In the first iteration, E, U, and N will be set equal to their pre-program equilibrium values. In subsequent interactions, the new equilibrium values are used. In practice for the types of simulations which are reported here, the iterative adjustments are small and the first round estimates are good approximations.

8. These data are unpublished and must be obtained from the Bureau of Labor Statistics. For a good summary of the data, their potential, and problems, the reader is referred to a recent paper by Smith and Vanski (1978).

9. The method of solution to Markov processes is described in Appendix C.

10. George Iden of the Congressional Budget Office has estimated that the increase in the number of person years funded in youth employment and training programs from fiscal 1977 to fiscal 1978 will be 172,000. See Iden (1978), Table 4.

11. The distinction between dropouts and completers is ignored here.

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